

Electronic Supplementary Information (ESI)

Construction of Cu@ZnO Nanobrushes Based on Cu Nanowires and Their High-performance Selectivity-degradation for Polycyclic Aromatic Hydrocarbons

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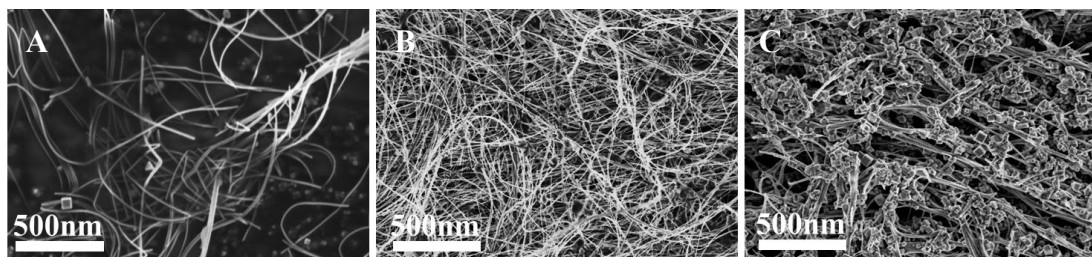


Figure S1. SEM image of Cu nanowires fabricated under different reaction temperature of 90°C A), 110°C B), and 130°C C).

Figure S1 gives the images of Cu NWs prepared under different reaction temperatures. Lower temperature may cause the fracture of nanowires and nanoparticles together with nanowires may be produced under the higher temperature.

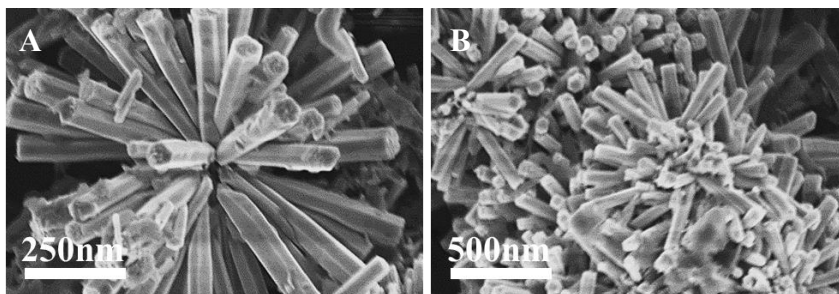


Figure S2. A-B) SEM images of ZnO nanoflowers directly grown from $\text{Zn}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ and HMT growth solution under 85°C for 6h.

As the Figure S2 shows, ZnO nanoflowers can directly be grown from the growth solution in the absence of Cu NWs as the non-planar substrates and ZnO nanoseeds as the starting sites. Image A and B are under different magnification times.

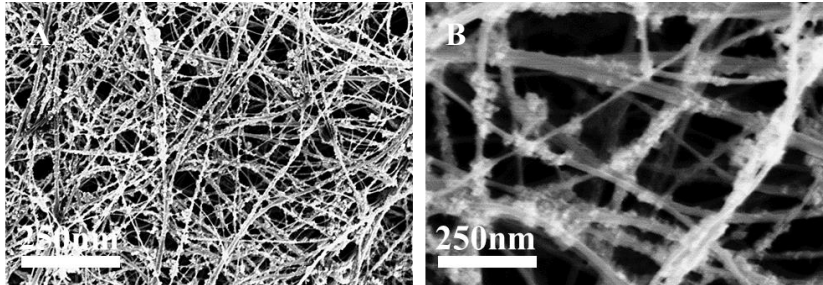


Figure S3. A-B) SEM images of Cu nanowires loaded ZnO nanoseeds after 4 h absorption.

The images in Figure S3 exhibits that the morphology of ZnO seed-coated Cu NWs during the process of the whole fabrication. ZnO nanoseeds can load on the surface of Cu NWs densely for the next hierarchical assemblies.

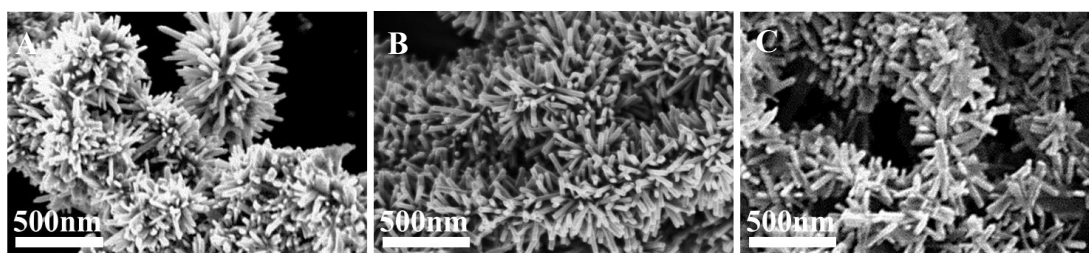


Figure S4. SEM images of Cu@ZnO nanobrushes synthesized under different temperatures of 75°C A), 85°C B), and 95°C C).

Figure S4 illustrates the SEM images monitored at different temperatures for the formation of Cu@ZnO nanobrushes. It can be observed that ZnO NRs arrange along the Cu NWs clearly and regularly under the temperature of 85°C.

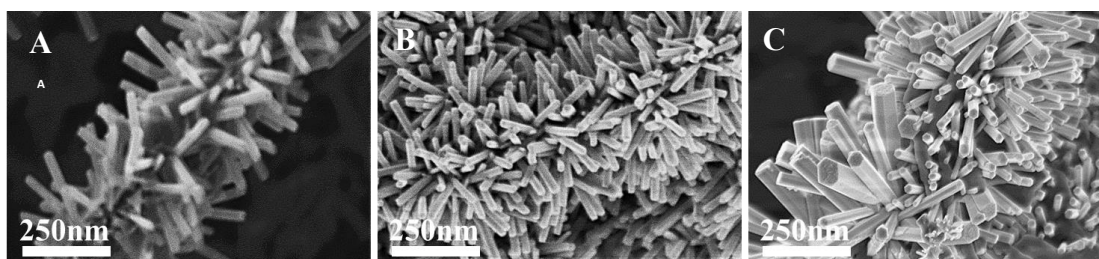


Figure S5. SEM images of Cu@ZnO nanobrushes synthesized with different volume of ZnO growth solution of 5mL A), 10mL B), and 20mL C).

Figure S5 shows ZnO NRs can arrange along the Cu NWs densely when the volume of growth solution is 10mL, neither sparsely with the volume of 5mL nor thickly with the volume of 20mL.

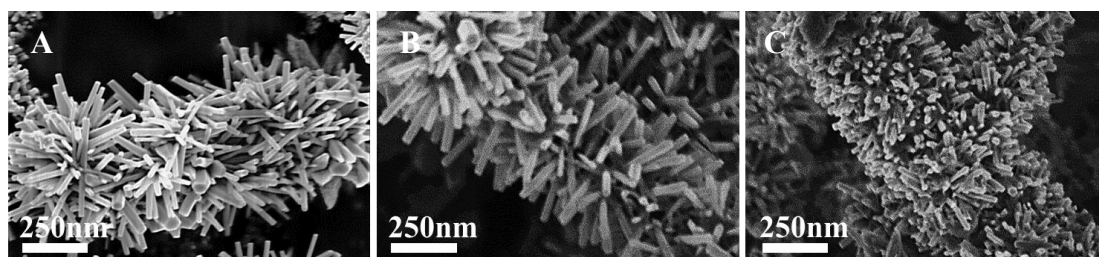


Figure S6. SEM images of Cu@ZnO nanobrushes synthesized with different Cu/ZnO molar ratio of 7.5/1 A), 9.3/1 B), and 12.5/1 C).

Figure S6 presents that it can be observed that the directional arrangement density of assembled ZnO NRs could be controlled by varying the molar ratio between Cu and ZnO using the optimized reaction temperature and volume of growth solution.

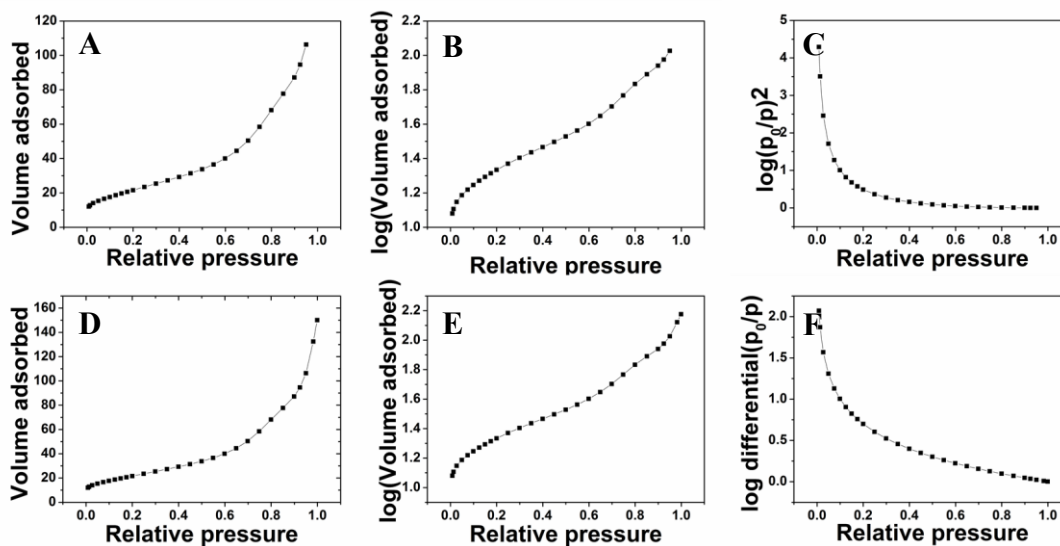


Figure S7. The adsorption curve of Cu@ZnO nanoburshes using Dubinin-Radushkevich analysis of volume adsorbed A), log volume adsorbed B) and $\log(p_0/p)^2$ C) and Dubinin-Astakhov analysis of volume adsorbed D), log volume adsorbed E) and $\log \text{differential}(p_0/p)$ F).

From Figure S7 B and E, it can be observed that the slope of the correlations between the relative pressure and volume adsorbed using Dubinin-Radushkevich or Dubinin-Astakhov method can be both regarded as linear relationships. And the nitrogen adsorption information showed in Figure S4 identity with that in Figure 1 F and G.

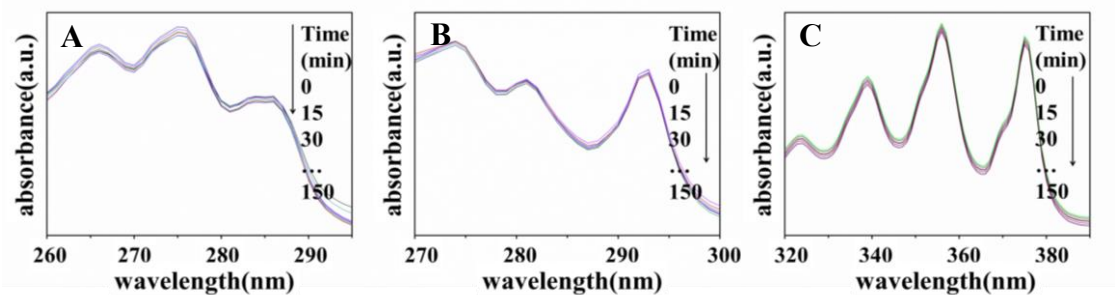


Figure S8. UV-vis spectra of the photocatalytic oxidation of naphthalene (A); phenanthrene (B); and anthracene (C) without any catalysts.

Figure S8 shows the blank experiment which was carried out where only polycyclic aromatic compounds without any photocatalyst was irradiated under UV-light, in order to exclude the possibility that the degradation of polycyclic aromatic compounds was caused by the UV-light irradiation. It can be clearly observed that the irradiation does not degrade polycyclic aromatic compounds including naphthalene, phenanthrene, and anthracene in the absence of catalysts.

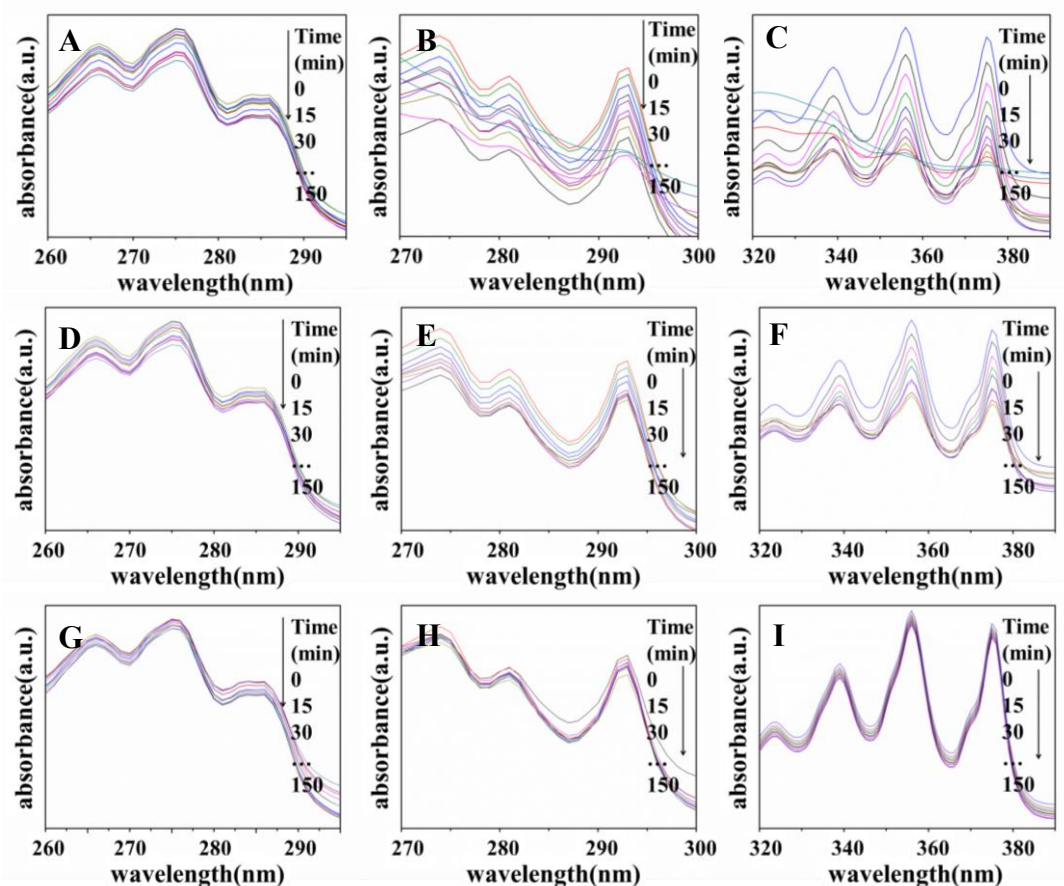


Figure S9. UV-vis spectra of the photocatalytic oxidation of naphthalene A), phenanthrene B), and anthracene C) catalyzed by Cu@ZnO nanorods; UV-vis spectra of the photocatalytic oxidation of naphthalene D), phenanthrene E), and anthracene F) catalyzed by ZnO nanorods and UV-vis spectra of the photocatalytic oxidation of naphthalene G), phenanthrene H), and anthracene I) catalyzed by Cu nanowires.

The photocatalytic degradation of naphthalene, phenanthrene, and anthracene over Cu@ZnO nanobrushes together with Cu NWs and ZnO NRs has been tested respectively under same condition. UV-vis spectra have been given in Figure S9. It can be clear observed that the photooxidation of naphthalene, phenanthrene, and anthracene can be negligible catalyzed by Cu NWs. And the catalytic activity of ZnO NRs is unsatisfactory, which is obviously lower than that of Cu@ZnO nanobrushes.

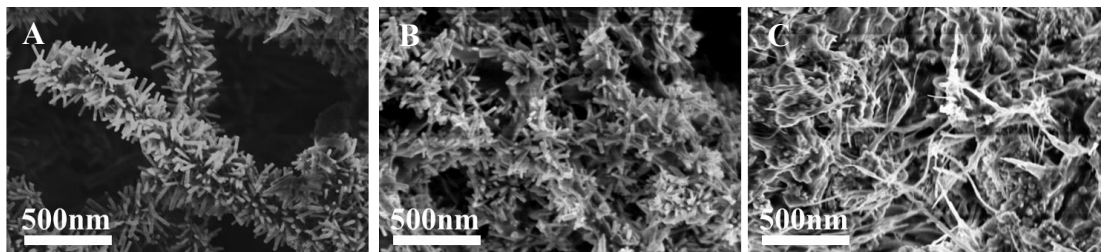


Figure S10. SEM images of Cu@ZnO nanobrushes morphology before the catalysis A), after 75min B) and after 150min C).

Figure S10 presents the SEM images of Cu@ZnO nanobrushes monitored at different reaction time for the catalysis process of anthracene. After catalyzed for 75min, the brush-like structure has deformed but ZnO NRs can still be observed. And the structure of catalysts has begun to collapse when the catalysis process last for 150min.

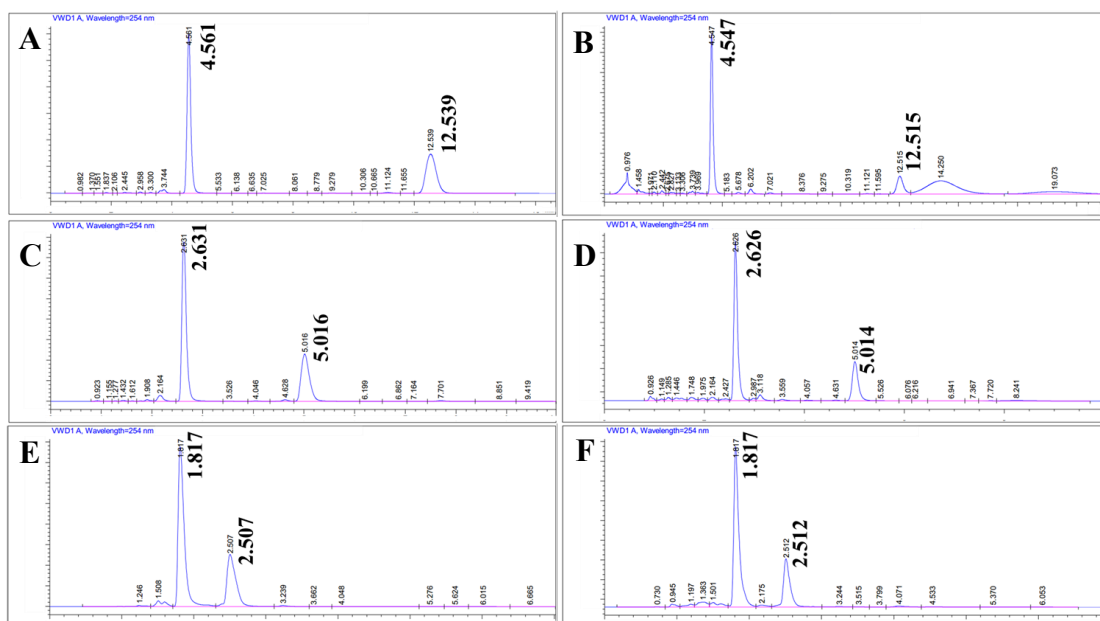


Figure S11. HPLC spectra of standard solution under different mobile phase of A) $\text{CH}_3\text{OH}:\text{H}_2\text{O}=7:3$; C) $\text{CH}_3\text{OH}:\text{H}_2\text{O}=8:2$ and E) $\text{CH}_3\text{OH}:\text{H}_2\text{O}=9:1$; and products catalyzed from anthracene by $\text{Cu}@\text{ZnO}$ nanobrushes after 150 min under different mobile phase of B) $\text{CH}_3\text{OH}:\text{H}_2\text{O}=7:3$; D) $\text{CH}_3\text{OH}:\text{H}_2\text{O}=8:2$ and F) $\text{CH}_3\text{OH}:\text{H}_2\text{O}=9:1$.

The standard solution mentioned in Figure S11 is composed by anthracene and anthraquinone with the molar ratio of 1:9 which correspond to the target components of products. The spectra show that the component of standard solution and catalysed products are almost the same. It can obviously prove that our products which were catalyzed by $\text{Cu}@\text{ZnO}$ nanobrushes are composed of nearly 90% anthraquinone and 10% anthracene that were still not degraded. That means anthracene can be successfully degraded to anthraquinone catalyzed by $\text{Cu}@\text{ZnO}$ nanobrushes.